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Synchrotron X-ray Analysis of Changes in Brain Levels of Zinc and Copper in Rats

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Beamline(s): X26A

Introduction: Zinc is a biologically essential trace metal that is found in over 100 enzymes and proteins. It is the fourth most abundant metal in the brain and has its highest levels in the hippocampus, a structure known to be essential for certain forms of memory, including spatial memory. Zinc deficiency has been well studied and has many adverse consequences, however, the effect of excess levels of zinc has not been well studied. We have shown that rats raised on excess levels of zinc in the drinking water do show spatial memory deficits, as assessed in the Morris Water Maze. (MWM) We were thus interested to see if the enhanced levels of zinc in the drinking water alone could affect brain levels of zinc. It had been generally assumed that this was not possible due to the brain's tight regulation of zinc levels. Zinc is often associated with copper in important neural enzymes. We were thus also interested to see how copper levels might be affected if the zinc levels in the brain changed.

Methods and Materials: Groups of rats were raised on water containing levels of ZnCO_3 of 20 and 40 ppm, and on lab water, both pre-and post-natally. They were tested in the MWM at 9 months of age. The brains of a subset of animals were then sliced and brain levels of zinc were measured using the X26A hard x-ray microprobe.

Results: Both zinc groups showed spatial memory deficits. However, there was no significant difference between the performances of the two zinc groups. Synchrotron X-ray analysis showed by visual inspection that the levels of zinc in the hippocampus and in adjacent regions of cortex were higher in the rats raised on enhanced levels of zinc. Copper levels were lower than zinc levels in all groups of rats. Statistical comparisons of the concentrations of both copper and zinc in different brain regions are in progress.

Conclusions: The results show that elevated zinc in drinking water significantly affects spatial memory. The analysis of a smaller number of animals indicates that brain levels of zinc also change. The synchrotron X-ray technique is extremely useful because it allows for the mapping of zinc and copper in the brain and its identification in specific structures, such as the hippocampus.